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(54) **INDUSTRIAL MICROWAVE OVEN FOR THE THERMAL TREATMENT OF PRODUCTS AND METHOD APPLIED THEREBY IN PARTICULAR FOR KILLING INSECTS IN WOOD**

INDUSTRIEMIKROWELLENOFEN ZUR WÄRMEBEHANDLUNG VON PRODUCTEN UND DABEI ANGEWENDETES VERFAHREN, INSBESONDERE ZUR TÖTUNG VON INSEKTEN IN HOLZ

FOUR A MICRO-ONDES INDUSTRIEL POUR LE TRAITEMENT THERMIQUE DE PRODUITS ET PROCEDE ASSOCIE DESTINE EN PARTICULIER A TUER LES INSECTES PRESENTS DANS LE BOIS

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Description

[0001] The present invention concerns an industrial microwave oven for the thermal treatment of products as well as a method applied thereby, in particular for killing insects in wood.

[0002] Although the invention can be applied for the thermal treatment of all sorts of products, the invention is specifically meant for drying wood, in particular for killing insects and larvae, such as 'lictus brunneus', which may be present in the wood.

[0003] Such microwave ovens for the thermal treatment of products on an industrial scale are already known from Dutch patent No. 8103118, whereby the products to be treated are guided through the oven space of the microwave oven on a conveyor belt and whereby these products are heated by microwaves coming from a number of smaller magnetrons situated on the outside of the oven space on the one hand, and by hot-air currents coming from the cooling of the magnetrons on the other hand.

[0004] The microwaves are guided from the magnetrons to the oven space via wave guides which flow into openings in the upper wall of the oven space, which microwaves are further radiated in the aforesaid openings in the oven space by means of antenna radiators, whereas the above-mentioned air currents are blown in the oven space via separate openings in the side walls.

[0005] Another microwave oven of the prior art is disclosed by GB943500.

[0006] Although such known industrial microwave ovens in general provide good results, it is found in practice in certain cases that the products to be treated, depending on their nature and shape, are heated in an irregular manner and that, especially in places opposite to the antenna radiators, the temperatures of the products can rise to detrimental heights, as a result of which the products are locally overheated, whereas the thermal treatment of the products proves to be insufficient in other places.

[0007] Another disadvantage of such known microwave ovens is that, in order to fight insects in wood, whereby it is important for the wood to be exposed to sufficiently high temperatures for a sufficient length of time, relatively much energy is consumed.

[0008] The present invention aims to remedy the above-mentioned and other disadvantages by providing an industrial microwave oven which makes it possible to thermally treat products in an efficient, economical and uniform manner in order to dry them and/or to fight insects and larvae which might be present in it.

[0009] To this end, the invention concerns an industrial microwave oven for the thermal treatment of products, which mainly consists of an oven space which is limited by a metal case; one or several magnetrons onto which are connected one or several wave guides which open into the oven space with one outlet via openings in the upper wall of the above-mentioned case; one or several antenna radiators provided in the above-mentioned outlets, means in the shape of fans for cooling the magnetrons by means of gas flows, whereby a part of the above-mentioned gas flows are blown into the oven space via the aforesaid wave guides and circulators or insulators comprising ferrites are located in the waveguides in such a manner that the at least a part of said gas flows are blown into the oven space via the circulators or insulators.

[0010] As the gas flows and the microwaves are guided to the oven space via the same wave guides, they have the same direction when they leave said wave guides, as a result of which the gas flows end up on the products to be treated in places opposite to the antenna radiators which are heated most of all by the microwave oven, so that the gas flows will have a cooling effect in these places, whereas in other places, where the microwaves are less concentrated, they will rather have a heating effect.

[0011] This offers the advantage that the gas flows have a stabilising effect, as if it were, on the temperature peaks occurring in the known microwave ovens in places opposite to the antenna radiators, and that the products to be treated are consequently heated in a more uniform manner.

[0012] The invention also concerns a method for treating products, in particular for killing insects and larvae in wood, whereby the method mainly consists in briefly heating the wood in a microwave oven according to the invention up to a temperature which, when leaving the microwave oven, is considerably higher than the minimal killing temperature of the insects and larvae, and of subsequently letting the wood cool off outside the microwave oven, whereby the above-mentioned temperature when leaving the microwave oven is such that, after the wood has cooled to the minimal killing temperature, all insects and larvae will have been killed.

[0013] An advantage of this method is that less energy is required for killing insects and larvae in this manner than with the known methods whereby the wood is heated less fiercely, but for longer periods in order to make sure that all insects and larvae have been killed, and whereby the cooling period outside the oven is not taken into account.

[0014] In order to better explain the characteristics of the invention, two preferred embodiments of an industrial microwave oven according to the invention and of a method applied thereby are described as an example only without being limitative in any way, with reference to the accompanying drawings, in which:

figure 1 schematically represents a microwave oven according to the invention for the thermal treatment of wood boards in perspective;
figure 2 represents a section according to line II-II in figure 1;
figure 3 represents a curve of the variation in temperature applied for the treatment of wood in order to kill insects and larvae;
figure 4 represents a variant of figure 2.

[0015] Figures 1 and 2 represent an industrial microwave oven 1 according to the invention for the thermal treatment of products 2, in this case for the treatment of wooden boards.

[0016] The microwave oven 1 is provided with a conveyor belt 3 for the products 2 to be treated, which conveyor belt 3 consists of an endless belt 4 which is preferably provided with perforations 5 and which is guided over two or several rollers, 6 and 7 respectively, which are bearing-mounted in a frame which is not represented in the figures, whereby one roller 6 is provided with a drive 8 in the - shape of a motor or the like.

[0017] Above the aforesaid conveyor belt 3 is preferably provided a metal case which is composed of a central case 9 without a bottom on the one hand, extending over the width of the conveyor belt 3, and of two or several higher cases which are mainly closed, 10 and 11 respectively, provided on either side of the conveyor belt 3 against the side walls of the central case 9, whereby an opening 12 is provided in these cases 10-11, for example in the bottom, covered by a filter 13.

[0018] Although a central case 9 whose bottom is open is described as an example here, it is not excluded that, according to a variant which is not represented, the central case (9) is provided with a sealed bottom, whereby the top part of the endless belt 4 is in this case guided through the central case 9 via openings in the front and back wall of the central case 9.

[0019] On either side of the conveyor belt 3, the microwave oven 1 is provided with a number of tubular wave guides situated opposite to each other, 14 and 15 respectively, provided with a vertical part 16 against the inner side of the side walls 17-18 of the cases 9 and 10 turned towards each other, and provided with a horizontal part 19 through openings in the above-mentioned side walls 17-18 and fixed on the top wall 20 of the central case 9, whereby these horizontal parts 19 preferably extend crosswise to the direction of transport, and up to almost the middle of the top wall 20.

[0020] Both far ends of the wave guides 14-15 are sealed by means of end walls, 21 and 22 respectively.

[0021] On each wave guide 14-15, at the height of the top end of the vertical part 16, is provided a duct 23 whose outlet is connected to a lateral opening 24 in the wall of the wave guide 14-15 concerned and in which is provided a magnetron 25 which sticks with its antenna 26 in the wave guide 14-15 and which is fed by a transformer 27 provided in the case 9-10.

[0022] The microwave oven 1 is provided with means for cooling the magnetrons 25 in the shape of fans 28 erected at the entries of the above-mentioned ducts 23.

[0023] Each wave guide 14-15 is provided over practically the entire length of the horizontal part 17 with a downward directed outlet 29 which opens in the central case 9 via an opening in the above-mentioned upper wall 20.

[0024] In the above-mentioned outlets 29 of the wave guides 14-15 are provided a number of antenna radiators 30 at regular distances from each other which are represented here as dipoles by way of example, but which could just as well be realised in the shape of slotted lines, leaky waves or the like.

[0025] The working and use of the industrial microwave oven 1 according to the invention is very simple and as follows.

[0026] The products 2 to be treated are loaded on the conveyor belt 3 and are thus carried under the central case 9.

[0027] During this transit, the magnetrons 25 are excited and the microwaves 31 developed by the magnetrons 25 are radiated into the central case 9 via the wave guides 14-15 and the antenna radiators 30 onto the products 2 to be treated, as a result of which these products 2 will be heated.

[0028] The space 32 which is limited by the central case and by the conveyor belt 3 thus forms the actual oven space of the microwave oven 1.

[0029] Simultaneously with the magnetrons 25 also the fans 28 are excited, as a result of which air is drawn in via the openings 12 and filters 13 and blown into the ducts 23 in order to cool the magnetrons 25.

[0030] The heated cooling air is guided further to the oven space 31 via the wave guides 14-15, where the cooling air, as represented by the arrows P, flows over the products 2 to be treated and is guided outside via the perforations 5 in the conveyor belt.

[0031] The cooling air as if it were largely follows the same path as the microwaves 31, as a result of which, on the places opposite to the antenna radiators 30, where the microwaves 31 are concentrated the most, the air flow has a cooling effect, and as a result of which the products 2 will be heated in a more uniform manner than in the known microwave ovens.

[0032] It is clear that, depending on the nature of the products to be treated and the nature of the required treatment, it is possible to take advantage of the power and positioning of the magnetrons 25 and antenna radiators 30, as well as of the speed of the conveyor belt 3, as a result of which the duration of the treatment can be adjusted as required.

[0033] A practical realisation of a microwave oven according to the invention for the treatment of wood, in particular for drying wood and for killing insects and larvae of the 'lictus brunneus' family, is described hereafter by way of example.

[0034] For this application, use can be made with good results of a microwave oven 1 whereby sixteen magnetrons of 2 kW each are provided in every case 10-11, operating at a frequency of 2450 Hz, situated at a distance of some 25 centimetres from each other, and whereby each time 16 antenna radiators 30 are provided in the outlets 29 of the wave guides 14-15.

[0035] Figure 3 represents the temperature curve of the product 2 during a treatment in the above-described practical embodiment.

[0036] In order to kill the 'lictus brunneus', it is important

that the temperature T of the product 2 to be treated exceeds a minimal killing temperature TMIN of some 60°C during a length of time DS of some 280 seconds.

[0037] The curve of figure 3 shows that this is obtained by shortly heating the product 2 between the point of time A at which it enters the microwave oven 1 and the point of time B at which it leaves the microwave oven 1, such that, when it leaves the microwave oven 1, a temperature TB of at least 70°C is reached which is considerably higher than the above-mentioned killing temperature.

[0038] Once it is outside the microwave oven 1, the product 2 gradually cools and reaches the above-mentioned killing temperature TMIN again at the point of time C.

[0039] The speed of the conveyor belt 3 is adjusted such that the temperature TB of the product 2, when it leaves the microwave oven 1, is sufficiently high for the length of time (C-D) during which the temperature T of the product is higher than TMIN, to be at least equal to the above-mentioned length of time DS which is required to efficiently kill the insects and the larvae.

[0040] With the known microwave ovens, the product 2 is heated during the entire length of time DS, which requires much more energy compared to the method according to the invention whereby the product 2 is only shortly heated.

[0041] It is clear that, instead of air, also other gases can be used to cool the magnetrons 25 and to treat the products 2, whereby the openings 12 in the lower side of the cases 10-11 can in this case be connected for example to a gas supply or the like.

[0042] Thus, for example, an insecticidal gas can be used to kill the insects and larvae.

[0043] Another application is the use of nitrogen which can be used for example in case of emergency to extinguish a possible fire in the microwave oven 1.

[0044] In this manner, the climate in the actual oven space 31 can be perfectly conditioned, depending on the required application.

[0045] Figure 4 represents a variant of a microwave oven 1 according to the invention whereby additional fans 28 are in this case placed at the openings 12 of the cases 10-11 which offer the advantage that larger cooling flow rates can be realised which can moreover be guided along the above-mentioned transformers 27 for a better cooling of the latter.

[0046] In the wave guides 14-15 are in this case inserted circulators 32 and/or insulators in the known manner in view of the security which, as is known, are provided with a core on the basis of ferrites.

[0047] In the known devices, these circulators 32 and insulators often cause problems related to air penetration at the height of the ferrites, due to the air humidity in the wave guides.

[0048] In the case of the invention, however, there are no such problems since the air or gas flow in the wave guides provides for a sufficient discharge of the moisture.

[0049] Although in the figures, the wave guides 14-15 are situated on the top wall 20 in each other's prolongation, it is not excluded for these wave guides 14 and 15 to be applied crosswise in relation to each other and to preferably extend over the entire or almost the entire width of the top wall 20 in this case.

[0050] The invention is by no means limited to the above-described embodiments given as an example and represented in the accompanying drawings; on the contrary, such an industrial microwave oven according to the invention and a method applied thereby can be made in all sorts of variants while still remaining within the scope of the invention.

Claims

1. Industrial microwave oven for the thermal treatment of products, the microwave oven (1) comprising:

   an oven space (32) which is bounded by a first metal case (9);
   one or several magnetrons (25) onto which are connected one or several wave guides (14-15) which open into the oven space (32) with one outlet (29) via openings in an upper wall (20) of the first metal case (9);
   one or several antenna radiators (30) provided in the outlets (29);
   means for cooling the magnetrons (25) by means of gas flows, whereby at least a part of the above-mentioned gas flows are blown into the oven space (32) via the wave guides (14-15);
   characterised in that circulators or insulators comprising ferrites are located in the wave guides in such a manner that the at least a part of said gas flows are blown into the oven space via the circulators or insulators.

2. Industrial microwave oven according to claim 1, **characterised in that** every magnetron (25) is provided in a duct (23) which is connected to an opening (24) in the wall of the wave guide (14-15) of the magnetron (25) concerned.

3. Industrial microwave oven according to claim 2, **characterised in that** the means for cooling consist of a fan (28) which is located at the entry of the above-mentioned duct (23).

4. Industrial microwave oven according to claim 2, **characterised in that** the magnetrons (25) are provided in two second cases (10-11) which are practically sealed, on either side of the first metal case (9), whereby every second case (10-11) is at least provided with one opening (12) and **in that** the wave guides (14-15) of the magnetrons (25) concerned have openings (24) which are situated in the space of the second cases (10-11).

5. Industrial microwave oven according to claim 4 **characterised in that** the openings (12) in the second cases (10-11) are connected to a gas supply.

6. Industrial microwave oven according to claim 5 **characterised in that** the gas supply comprises at least one fan (28).

7. Industrial microwave oven according to claim 5, **characterised in that** the first metal case (9) is open at the bottom side, where a conveyor belt (3) is provided under this metal case (9).

8. Industrial microwave oven according to claim 5, **characterised in that** the first metal case (9) is sealed on the bottom side, whereby the endless belt (4) of a conveyor belt (3) is guided through this first metal case (9).

9. Industrial microwave oven according to any of claims 1 to 8, **characterised in that** the gas flows comprise air or nitrogen or an insecticidal gas.

10. Industrial microwave oven according to any of claims 1 to 9, **characterised in that** the one or several magnetrons each have an antenna (26) and that the antennas (26) are located in the waveguide and not in the oven space.

11. Industrial microwave oven according to any of claims 2 to 10, **characterised in that** the magnetrons are arranged in the ducts such that at least a part of the gas flows are blown into the oven space through the ducts and the wave guides to thereby cool the magnetrons.

12. Method for treating products in particular for killing insects and larvae in wood, **characterised in that** it mainly consists of briefly heating the wood in a microwave oven (1) according to any of the preceding claims up to a temperature (TB) which, when leaving the microwave oven (1), is considerably higher than the minimal killing temperature (TMIN) of insects and larvae, and of subsequently letting the wood cool off outside the microwave oven (1), whereby the above-mentioned temperature (TB) when leaving the microwave oven (1) is such that, after the wood has cooled to the minimal killing temperature (TMIN), all insects and larvae will have been killed.

13. Method according to claim 12 **characterised in that** the temperature (TB) of the wood when leaving the microwave oven (1) amounts to at least 70 °C.

14. The method according to claim 13, wherein the wood is maintained at a temperature of at least 60°C for at least 280 sec.

15. The method according to any of claims 12 to 14, wherein the microwave oven comprises an oven space (32) which is bounded by a first metal case (9), one or several magnetrons (25) onto which are connected one or several wave guides (14-15) which open into the oven space (32) with one outlet (29) via openings in an upper wall (20) of the first metal case (9) and nitrogen gas is blown into the oven space (32) via the wave guides (14-15), further comprising the step of extinguishing a fire in the microwave oven.

Patentansprüche

1. Industrieller Mikrowellenofen für die thermische Behandlung von Produkten, aufweisend:

einen Ofenraum (32), der von einem ersten Metallgehäuse (9) umgeben ist;
ein oder mehrere Magnetrons (25), mit denen ein oder mehrere Wellenleiter (14-15) verbunden sind, welche in den Ofenraum (32) mit einem Ausgang (29) über Öffnungen in einer oberen Wand (20) des ersten Metallgehäuses (9) geöffnet sind;
ein oder mehrere Antennenstrahler (30), die in den Ausgängen (29) angeordnet sind;
eine Einrichtung zum Kühlen der Magnetrons (25) mittels eines Gasflusses, wobei mindestens ein Teil des vorgenannten Gasflusses in den Ofenraum (32) mittels der Wellenleiter (14-15) geblasen wird;

dadurch gekennzeichnet, dass
Zirkulatoren oder Isolatoren, die Ferrite beinhalten, in den Wellenleitern derart angeordnet sind, dass mindestens ein Teil der Gasflüsse in den Ofenraum (32) über die Zirkulatoren oder Isolatoren geblasen wird.

2. Industrieller Mikrowellenofen nach Anspruch 1, **dadurch gekennzeichnet, dass** jedes Magnetron (25) in einem Kanal (23) vorgesehen ist, der mit einer Öffnung (24) in der Wand des Wellenleiters (14-15) des betroffenen Magnetrons (25), verbunden ist.

3. Industrieller Mikrowellenofen nach Anspruch 2, **dadurch gekennzeichnet, dass** die Einrichtung zum Kühlen aus einem Lüfter (28) besteht, der an dem Eingang des vorgenannten Kanals (23) angeordnet ist.

4. Industrieller Mikrowellenofen nach Anspruch 2, **dadurch gekennzeichnet, dass** die Magnetrons (25) in zwei zweiten Gehäusen (10-11) vorgesehen sind, die im Wesentlichen an jeder Seite des ersten Metallgehäuses (9) abgedichtet sind, wobei jedes zwei-

te Gehäuse (10-11) mindestens mit einer Öffnung (12) versehen ist, und dass die Wellenleiter (14-15) der betroffenen Magnetrons (25) Öffnungen (24), aufweisen, die in dem Raum der zweiten Gehäuse (10-11) angeordnet sind.

5. Industrieller Mikrowellenofen nach Anspruch 4, **dadurch gekennzeichnet, dass** die Öffnungen (12) in den zweiten Gehäusen (10-11) mit einer Gasversorgung verbunden sind.

6. Industrieller Mikrowellenofen nach Anspruch 5, **dadurch gekennzeichnet, dass** die Gasversorgung mindestens einen Lüfter (28) aufweist.

7. Industrieller Mikrowellenofen nach Anspruch 5, **dadurch gekennzeichnet, dass** der erste Metallofen (9) an der Unterseite offen ist, wobei ein Förderband (3) unter diesem Metallgehäuse (9) vorgesehen ist.

8. Industrieller Mikrowellenofen nach Anspruch 5, **dadurch gekennzeichnet, dass** das erste Metallgehäuse (9) an der Unterseite abgedichtet ist, wobei das Endlosband (4) eines Förderbandes (3) durch dieses erste Metallgehäuse (9) geführt ist.

9. Industrieller Mikrowellenofen nach einem der Ansprüche der 1 bis 8, **dadurch gekennzeichnet, dass** die Gasflüsse Luft oder Stickstoff oder ein Insektizidgas enthalten.

10. Industrieller Mikrowellenofen nach einem der Ansprüche 1 bis 9 **dadurch gekennzeichnet, dass** das eine oder die mehreren Magnetrons (25) jeweils eine Antenne (26) aufweisen und dass die Antennen (26) in dem Wellenleiter angeordnet sind und nicht in dem Ofenraum (32).

11. Industrieller Mirkowellenofen nach einem der Ansprüche 2 bis 10 **dadurch gekennzeichnet, dass** die Magnetrons in den Kanälen so angeordnet sind, dass mindestens ein Teil der Gasflüsse durch die Kanäle (23) und die Wellenleiter (14-15) in den Ofenraum (32) geblasen wird, um **dadurch** die Magnetrons (25) zu kühlen.

12. Verfahren zum Behandeln von Produkten, insbesondere zum Abtöten von Insekten und Larven in Holz, **dadurch gekennzeichnet, dass** es im Wesentlichen aus einem kurzen Aufheizen des Holzes in einem Mikrowellenofen (1) gemäß einem der vorhergehenden Ansprüche bis zu einer Temperatur (TB) besteht, die beim Verlassen des Mikrowellenofens (1) wesentlich höher als die minimale Abtötungstemperatur (TMIN) von Insekten und Larven ist, und wobei man nachfolgend das Holz außerhalb des Mikrowellenofens (1) abkühlen lässt, wobei die vorgenannte Temperatur (TB) beim Verlassen des Mikrowellenofens (1) so ist, dass nachdem das Holz bis zu der minimalen Abtötungstemperatur (TMIN) abgekühlt ist, alle Insekten und Larven getötet sind.

13. Verfahren nach Anspruch 12 **dadurch gekennzeichnet, dass** die Temperatur (TB) des Holzes beim Verlassen des Mikrowellenofens (1) auf mindestens 70°C ansteigt.

14. Verfahren nach Anspruch 13, wobei das Holz bei einer Temperatur von mindestens 60°C für mindestens 280 Sekunden gehalten wird.

15. Verfahren nach einem der Ansprüche 12 bis 14, wobei der Mikrowellenofen (1) einen Ofenraum (32) aufweist, welcher von einem ersten Metallgehäuse (9) umgeben ist, einem oder mehreren Magnetrons (25), welche mit ein oder mehreren Wellenleitern (14-15) verbunden sind, welche in den Ofenraum (32) mit einem Ausgang (29) über Öffnungen in einer oberen Wand (20) des ersten Metallgehäuses (9) offen sind und Stickstoffgas in den Ofenraum (32) über die Wellenleiter (14-15) geblasen wird und ferner ein Löschen eines Feuers in dem Mikrowellenofen (1) beinhaltet.

Revendications

1. Four hyperfréquence industriel pour le traitement thermique de produits, le four hyperfréquence (1) comprenant :

un espace formant four (32) qui est délimité par une première enceinte métallique (9) ;
un ou plusieurs magnétrons (25) auquel ou auxquels est ou sont reliés un ou plusieurs guides d'ondes (14 - 15) débouchant dans l'espace formant four (32) par un orifice de sortie (29), en passant dans des ouvertures ménagées dans une paroi supérieure (20) de la première enceinte métallique (9) ;
un ou plusieurs éléments rayonnants d'antenne (30), prévus dans les orifices de sortie (29);
des moyens pour refroidir les magnétrons (25) par des flux gazeux, au moins une partie desdits flux gazeux étant injectés par soufflage dans l'espace formant four (32), en passant par les guides d'ondes (14 - 15) ;
caractérisé en ce que des circulateurs ou des isolateurs comprenant des ferrites sont disposés dans les guides d'ondes de telle manière que ladite au moins une partie desdits flux gazeux soit injectée par soufflage dans l'espace formant four, en passant par les circulateurs ou les isolateurs.

2. Four hyperfréquence industriel selon la revendica-

tion 1, **caractérisé en ce que** chaque magnétron (25) est prévu dans un conduit (23) qui est relié à une ouverture (24) ménagée dans la paroi du guide d'ondes (14 - 15) du magnétron (25) concerné.

3. Four hyperfréquence industriel selon la revendication 2, **caractérisé en ce que** les moyens de refroidissement consistent en un ventilateur (28) qui est disposé au niveau de l'entrée dudit conduit (23).

4. Four hyperfréquence industriel selon la revendication 2, **caractérisé en ce que** les magnétrons (25) sont placés dans deux secondes enceintes (10 - 11) qui sont pratiquement étanches et situées de part et d'autre de la première enceinte métallique (9), chaque seconde enceinte (10 - 11) étant au moins pourvue d'une ouverture (12), et **en ce que** les guides d'ondes (14 - 15) des magnétrons (25) concernés comportent des ouvertures (24) qui sont situées dans l'espace défini par les secondes enceintes (10 - 11).

5. Four hyperfréquence industriel selon la revendication 4, **caractérisé en ce que** les ouvertures (12) prévues dans les secondes enceintes (10 - 11) sont reliées à une source d'alimentation en gaz.

6. Four hyperfréquence industriel selon la revendication 5, **caractérisé en ce que** la source d'alimentation en gaz comprend au moins un ventilateur (28).

7. Four hyperfréquence industriel selon la revendication 5, **caractérisé en ce que** la première enceinte métallique (9) est ouverte au niveau du côté inférieur, à l'emplacement auquel une bande transporteuse (3) est prévue au-dessous de cette enceinte métallique (9).

8. Four hyperfréquence industriel selon la revendication 5, **caractérisé en ce que** la première enceinte métallique (9) est hermétiquement fermée sur son côté inférieur, la courroie sans fin (4) d'une bande transporteuse (3) étant guidée à travers cette première enceinte métallique (9).

9. Four hyperfréquence industriel selon l'une quelconque des revendications 1 à 8, **caractérisé en ce que** les flux gazeux comprennent de l'air, ou de l'azote ou un gaz insecticide.

10. Four hyperfréquence industriel selon l'une quelconque des revendications 1 à 9, **caractérisé en ce que** le ou les magnétrons a, ou ont chacun, une antenne (26), et **en ce que** les antennes (26) sont situées dans le guide d'onde et non dans l'espace formant four.

11. Four hyperfréquence industriel selon l'une quelconque des revendications 2 à 10, **caractérisé en ce que** les magnétrons sont disposés dans les conduits de telle manière qu'au moins une partie des flux gazeux soit injectée par soufflage dans l'espace formant four, par l'intermédiaire des conduits et des guides d'ondes, pour ainsi refroidir les magnétrons.

12. Procédé de traitement de produits, notamment pour tuer des insectes et des larves dans du bois, **caractérisé en ce qu'**il consiste essentiellement à chauffer brièvement le bois dans un four hyperfréquence (1) selon l'une quelconque des revendications précédentes, jusqu'à une température (TB) qui, lorsqu'il quitte le four hyperfréquence (1), est considérablement plus élevée que la température minimale (TMIN) requise pour tuer les insectes et les larves, et ensuite à laisser le bois refroidir à l'extérieur du four hyperfréquence (1), ladite température (TB) étant telle, à la sortie du four hyperfréquence (1), que, après que le bois a été refroidi jusqu'à la température minimale (TMIN), tous les insectes et toutes les larves ont été tués.

13. Procédé selon la revendication 12, **caractérisé en ce que** la température (TB) du bois à sa sortie du four hyperfréquence (1) est d'au moins 70 °C.

14. Procédé selon la revendication 13, dans lequel le bois est maintenu à une température d'au moins 60 °C pendant au moins 280 s.

15. Procédé selon l'une quelconque des revendications 12 à 14, dans lequel le four hyperfréquence comprend un espace formant four (32) qui est délimité par une première enceinte métallique (9), un ou plusieurs magnétrons (25) auquel ou auxquels est ou sont reliés un ou plusieurs guides d'ondes (14 - 15) qui débouchent dans l'espace formant four (32) par un orifice de sortie (29), en passant dans des ouvertures ménagées dans une paroi supérieure (20) de la première enceinte métallique (9), de l'azote étant injecté par soufflage à l'intérieur de l'espace formant four (32) en passant par les guides d'ondes (14 - 15), et le procédé comprenant en outre l'étape d'extinction d'un feu dans le four hyperfréquence.

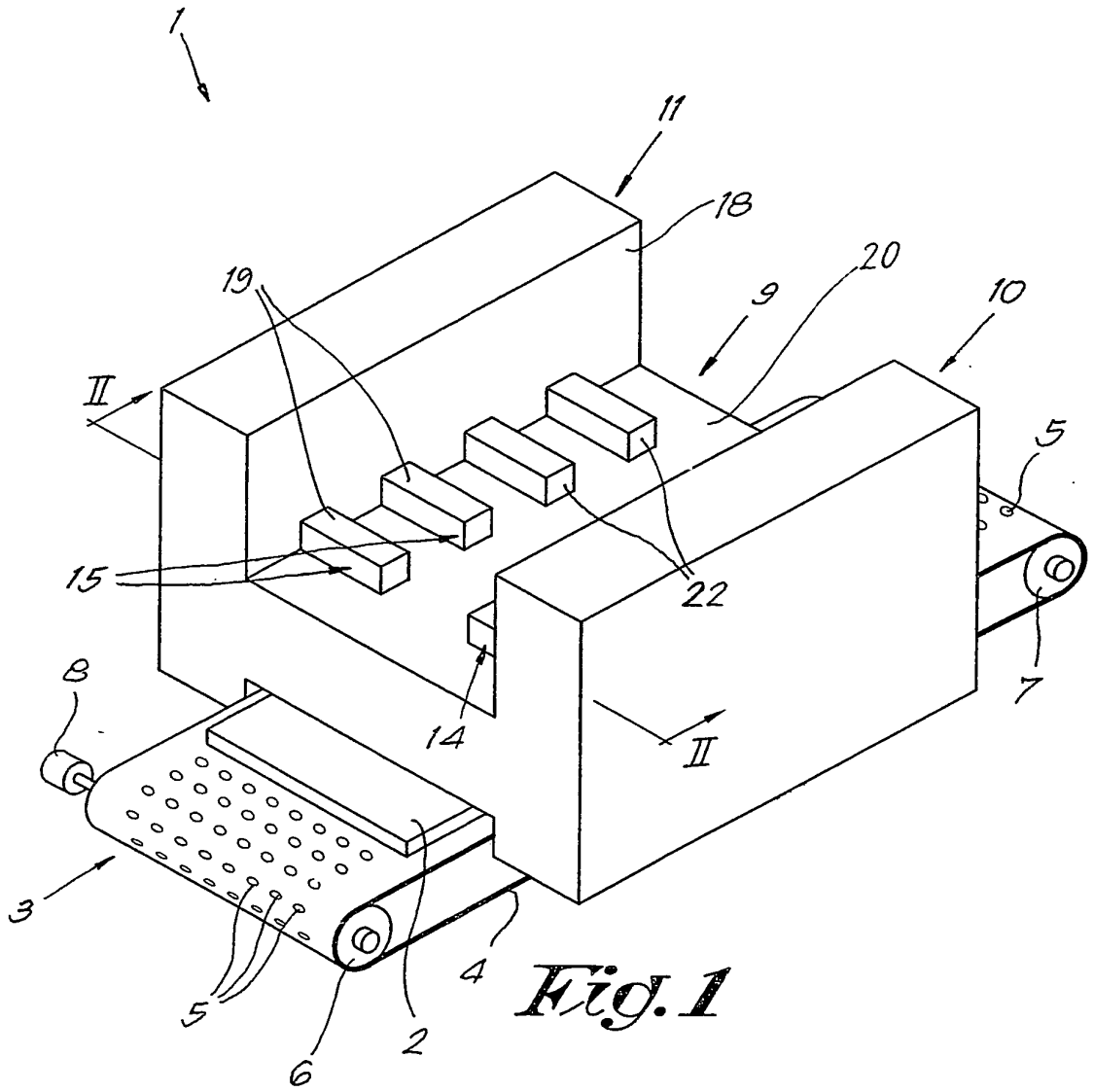

Fig. 1

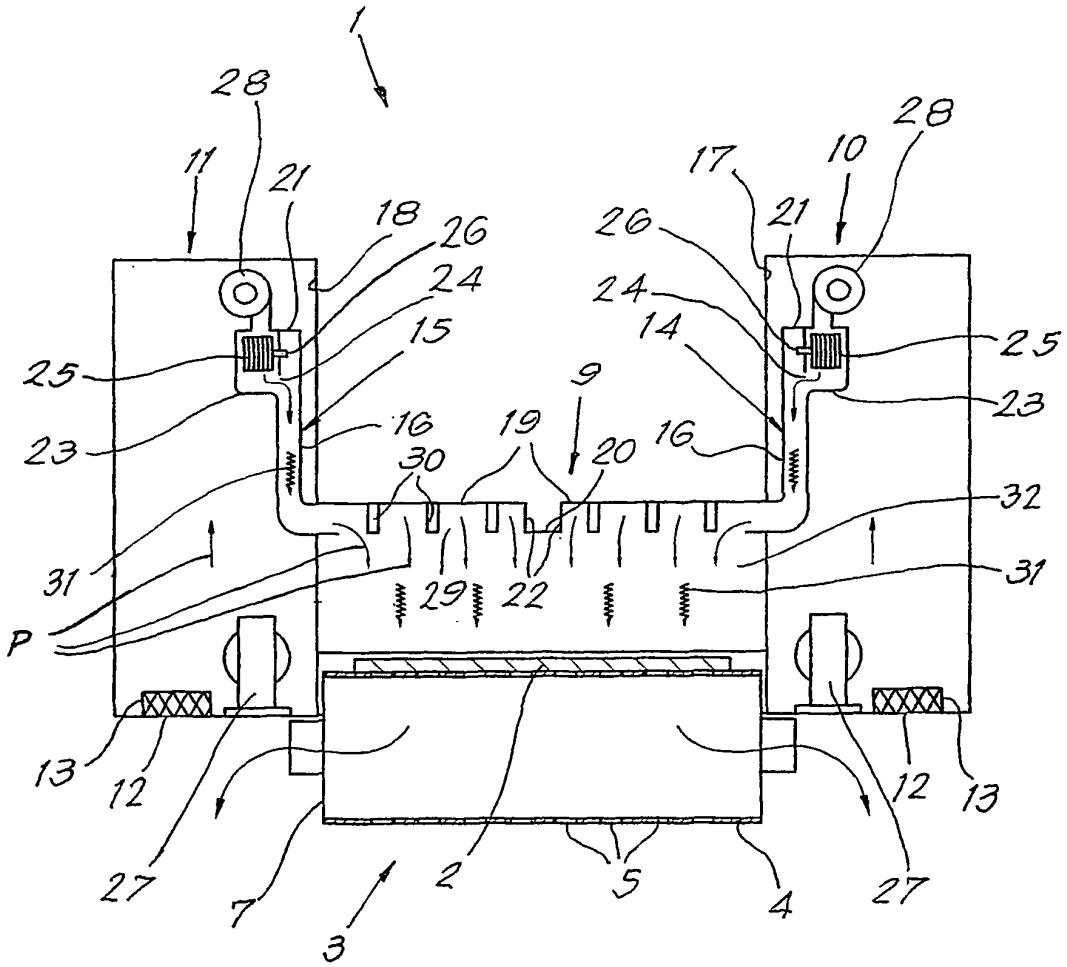
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Fig.2

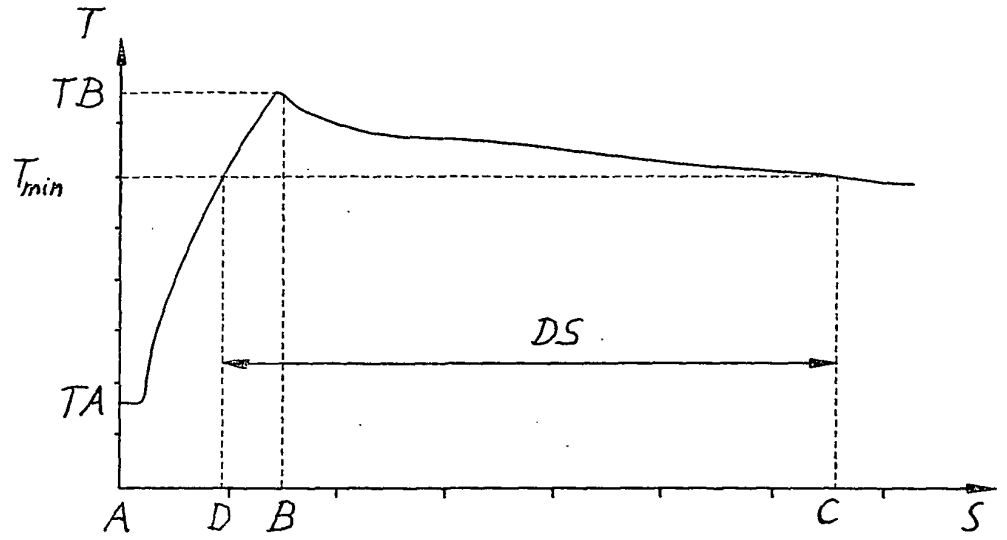
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Fig.3

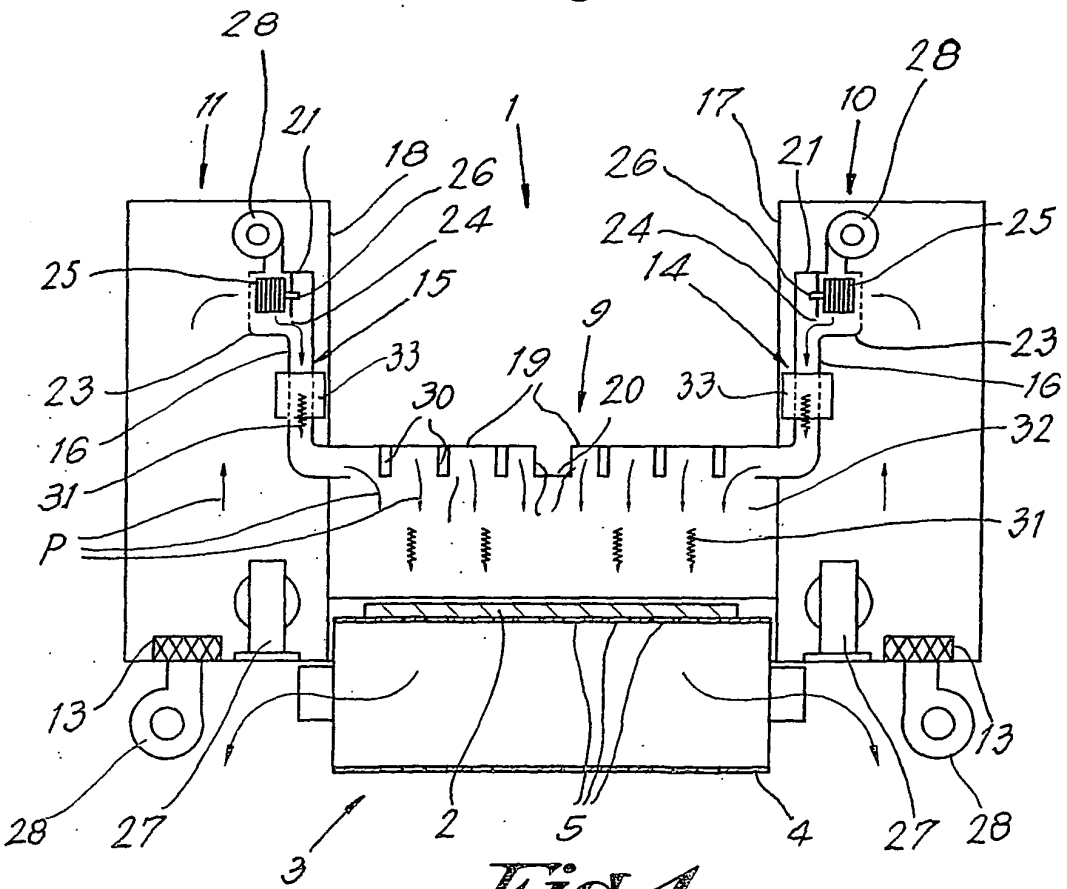
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Fig.4